

TROPICAL CYCLONES AS BIOCLIMATIC ACTIVATORS

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Like frontal cyclones but to a much greater degree, tropical cyclones are distinguished by low pressure, high wind, and heavy precipitation

The bioclimatic effects of low pressure generally have been outlined by many authors, e.g. Piery *et al.* (1934) and Seybold, Wolterreck *et al.* (1952), but in the main these effects are lasting only if the exposure to low pressure is permanent, as in mountain climates (see for instance Monge, 1948, for the effect of Andean altitude on man), or frequently repeated, as mentioned by Dexter (1904) or by Huntington (1930) also with regard to human populations. It is known that a rapid drop in atmospheric pressure causes restlessness in animals, but this effect disappears just as rapidly as soon as pressure returns to normal. Observations of restlessness in horses and dogs and of fitful sleep in humans at times of rapidly falling pressure have been made many times, but so far nothing shows that these effects will recur, unless of course similar atmospheric conditions arise later on.

FREQUENCY

Tropical cyclones are not common events. By combining the records compiled by Visser and Hodge (1925) with the data kindly supplied by the Perth Weather Bureau, one finds that from 1870 to 1955 inclusive there have been recorded 178 tropical cyclones, i.e. an average of 2 per year. From data published by Tannehill (1952) revised by the exclusion of the earliest obviously incomplete records, one obtains the following table:

TABLE I—WORLD OCCURRENCE OF TROPICAL CYCLONES

Area	Number of cyclones	Period of record	Number of years	Cyclones per year
East Asian waters	855	1880-1920	41	20.8
Bay of Bengal	365	1877-1912	36	10.2
Madagascar etc.	520	1848-1917	70	7.4
Caribbean - N. Atlantic	416	1887-1944	58	7.2
S.W. Pacific (ex. Qld.)	164	1870-1923	54	3.1
Queensland and N.T.	181		1870-1924	55
Western Australia	178	1870-1955	86	2.0
Arabian Sea	43	1890-1912	23	1.9
Callifornian waters	94	1832-1923	92	1.0

The table shows that tropical cyclones are far more common on the eastern sides than on the western sides of continents. If the cyclones of the Pacific south of the Equator are added to those of Queensland and the Northern Territory the frequency rises to 6.4 per year. It should be noted, however, that records are generally incomplete, especially over wide expanses of ocean, and that the definition

of tropical cyclone varies from time to time and place to place. Tannehill (1952) recalls that only between one-third and two-thirds of the tropical cyclones of the Caribbean and North Atlantic area reach hurricane intensity. Quite a number of tropical cyclones recorded in Western Australia cause no damage and would go unnoticed but for the thoroughness of meteorological records; on the other hand, many tropical cyclones formed in the Timor Sea or between Cocos and Australia travel for thousands of miles over the ocean and are never recorded.

Tropical cyclones recorded in Western Australia and nearby waters are as follows:

TABLE II
MONTHLY FREQUENCY OF TROPICAL CYCLONES IN WESTERN AUSTRALIA

Decade	A	S	O	N	D	J	F	M	A	M	J	J	Total
1870-1879 ...	—	—	—	1	4	3	7	4	2	2	—	—	23
1880-1889 ...	—	—	—	—	1	7	5	3	1	—	—	—	17
1890-1899 ...	—	—	—	1	3	4	—	1	1	—	—	—	10
1900-1909 ...	—	—	—	—	1	5	2	3	3	—	—	—	14
1910-1919 ...	—	1	1	1	1	5	4	6	—	—	—	1	20
1920-1929 ...	—	—	—	—	4	3	5	10	1	—	—	—	23
1930-1939 ...	—	—	—	—	1	5	4	6	—	—	—	—	16
1940-1949 ...	—	—	—	2	2	8	7	12	2	1	—	—	34
1950-1955 ...	—	—	—	—	3	4	8	2	4	—	—	—	21
1870-1955 ...	—	1	1	5	20	44	42	47	14	3	—	1	178
Per 10 years	0	0.1	0.1	0.6	2.3	5.1	4.9	5.4	1.6	0.3	0	0.1	20.5
Per 30 days ...	0	0.01	0.01	0.06	0.22	0.49	0.52	0.52	0.16	0.03	0	0.01	0.17

The data published by Visher and Hodge (1925) can be brought up to date from the records kindly made available by the Perth Weather Bureau.

TABLE III—TROPICAL CYCLONES IN WESTERN AUSTRALIA, 1925-1955

Season	N	D	J	F	M	A	M	Season	N	D	J	F	M	A	M
1924-1925	—	—	1	1	—	—	—	1940-1941	—	—	—	—	1	—	—
1925-1926	—	—	1	—	—	—	—	1941-1942	—	—	2	1	—	—	—
1926-1927	—	1	—	—	4	—	—	1942-1943	1	—	—	1	2	1	—
1927-1928	—	—	—	1	2	—	—	1943-1944	1	—	1	—	1	—	—
1928-1929	—	—	—	1	—	—	—	1944-1945	—	—	1	—	1	—	—
1929-1930	—	—	1	1	—	—	—	1945-1946	—	—	2	1	1	—	—
1930-1931	—	1	1	—	1	—	—	1946-1947	—	1	—	2	3	—	—
1931-1932	—	—	—	—	—	—	—	1947-1948	—	1	—	1	1	1	—
1932-1933	—	—	—	—	—	—	—	1948-1949	—	—	1	1	1	—	1
1933-1934	—	—	—	—	2	—	—	1949-1950	—	—	2	1	—	—	—
1934-1935	—	—	—	—	2	—	—	1950-1951	—	1	—	5	1	—	—
1935-1936	—	—	1	—	—	—	—	1951-1952	—	—	1	1	—	3	—
1936-1937	—	—	1	1	1	—	—	1952-1953	—	—	—	—	1	1	—
1937-1938	—	—	—	1	—	—	—	1953-1954	—	—	—	—	—	—	—
1938-1939	—	—	1	1	—	—	—	1954-1955	—	2	1	—	—	—	—
1939-1940	—	—	1	—	1	—	—	1955-1956	—	—	—	1	—	—	—

A comparison of tables II and III shows how misleading averages may be — the mean number of tropical cyclones per year is 2, and yet in the last 22 years there were three seasons with no cyclones (1931-32, 1932-33, 1953-54), five seasons with 1, nine with 2, seven with 3, three with 4, three with 5 (1926-27, 1942-43, 1951-52), one with 6 (1946-47) and one with 7 (1950-51), not all of which, however, reached the mainland. If calendar years are taken, one finds several years with 3 cyclones, some with 4, 1917, 1943 and 1952 with 5 each, 1947 and 1951 with 6 each.

The calendar year is a most unsuitable period for the recording of tropical cyclones, which are most frequent from November to March; the official list of tropical cyclones for 1917 shows one in January, two in March, one in October and one in December, whereas the season 1917-1918 recorded only three tropical cyclones, in October and December 1917 and in February 1918. With the increased frequency of ships' observations and the improvement of communications the records are now augmented by the inclusion of tropical cyclones at sea, which would have escaped notice only a few years earlier. In 1923 there was a violent cyclone which hit Carnarvon in January, then on March 8 two cyclones were recorded, one of them off Wallal, the second one between the North-West coast and Timor. Between March 18 and March 24 the fourth cyclone of the season occurred from Condon southwards. Only a few years earlier, the third cyclone of this season would have gone unnoticed, or at least unrecorded. The season with the greatest number of recorded cyclones is 1950-1951, with a cyclone in December 1950, five cyclones in February and one in March 1951, a total of seven. And yet only the December 1950 cyclone passed over the mainland — two of the February 1951 cyclones skirted the North-West coast without crossing it, and the remaining cyclones of the season were far out at sea. It is certain that many cyclones, perhaps an average of two a year, go completely unrecorded in the eastern Indian Ocean.

BIRD TRANSPORTATION

One striking effect of cyclones is the carrying of birds hundreds and at times thousands of miles beyond their usual habitat. In 1917 a violent tropical cyclone was first recorded some 200 miles north of Onslow on March 12. It passed Onslow by March 13 and continued very slowly southwards, crossing out to sea again a few miles north of Geraldton on March 16. On this occasion the White-winged Black Tern (*Chlidonias leucoptera*) was first recorded in Western Australia at Doodlakine (Serventy 1947). Early in April 1917 another tropical cyclone developed somewhere in the Arafura Sea, travelling close to the coast and passing off Derby on April 2, off Roebourne on April 3, off Onslow on April 5, and off Fremantle on April 7. Whether the new cyclone brought a much larger additional population of *C. leucoptera* or whether it merely pushed further south the population already displaced by the early-March cyclone may never be known. Alexander (1917) stated that almost every swamp and estuary between Moora and Balingup had parties of the birds feeding over them, preying mostly on the dragon-fly

Hemianax papuensis, also present in unusual numbers, most likely through the same cause. It should be noted that the birds remained only about a month in this area, and then disappeared, probably having returned north. Smaller numbers — hundreds — were recorded near Perth late in April 1918 (Alexander 1918) but this second invasion cannot be related to any recorded eyelone, although Glauert (*in litt.*) states that the visit "coincided with stormy weather."

When the March 1956 cyclone crossed the coast near Mandurah, thousands of these terns were blown ashore in an exhausted condition, possibly after having tried to work against the wind to avoid being blown inland. Many of the birds recovered, and V. N. Serventy (*in litt.*) noticed them two weeks later not only near Mandurah, but also near Point Peron and on Bibra Lake.

Serventy and Whittell (1948) quote the case of a Common Noddy (*Anous stolidus*) "found at Leighton in November 1946, following a very severe gale, but the species was, at the time, in residence at the Abrolhos."

Another tropical sea-bird which has been recorded in southern areas is the Red-tailed Tropic-bird (*Phaethon rubricauda*) which according to the same authors breeds in the Abrolhos Islands and travels north and south, having been recorded as sitting on an egg at Busselton. This bird is not gregarious and undertakes long lonely flights which are quite distinct from both migratory and accidental flights. Condon (*in litt.*) confirms that three specimens of this bird have been captured in South Australia, near Port Lincoln, January 13, 1919, and on Pearson Island January 1923 and March 20, 1926. There is no record of any tropical cyclone for several months prior to March 1919, so the first capture mentioned cannot be ascribed to forced transportation. In January 1923 a tropical cyclone was recorded off Broome, travelled along the coast for a week, being off Geraldton on January 18, off Fremantle on January 19, and cutting the coast near Mandurah to pass over Kalgoorlie on January 20 and into the Great Australian Bight half a day later. This cyclone may have contributed to the unusual displacement of the first Pearson Island bird. The two cyclones of 1926 were too far north to affect South Australia.

Serventy and Whittell (1948) mention that the Lesser Frigate-bird (*Fregata ariel*) nests from Bedout Island — near Port Hedland — northwards, but "during summer 'willy willies' the birds range south, preceding the storm centre, and on several occasions have been reported as far south as Point Cloates." The Greater Frigate-bird (*Fregata minor*) does not breed in Western Australia. A specimen was "captured alive on the Swan River estuary on May 4, 1917, after stormy weather." The time of the year and the fact that the bird belonged to the race which breeds on Christmas Island make one surmise that it was the strong north westerly wind associated with winter eyelones and not a tropical cyclone that drove the bird out of its usual range.

A totally unrelated and much more common summer visitor is the Fork-tailed Swift (*Micropus pacificus*), whose arrival generally

coincides with "stormy and humid weather caused by northern low-pressure systems" (Serventy and Whittell, 1948). The fact that records of this bird in the southern parts of Western Australia are all between October and April, with a maximum during January and February, seems to point to tropical cyclones as the main reason for the unusual displacement.

An exceptionally large number of these birds were seen by V. N. Serventy flying very high over Nedlands, just within range of strong field glasses, on Saturday, March 3, 1956, when strong north-easterly winds were blowing, preceding the arrival of a violent tropical cyclone the following day. The cyclone travelled along a peculiar track, which made it go over the Kimberleys twice, and then skirt the coast for nearly 1800 miles between February 27 and March 4. On March 4 the cyclone crossed the coast near Mandurah, and with it came thousands of Fork-tailed Swifts, many of them dropping to the ground in a dead or dying condition because of starvation.

The records thus show that although thousands of individual birds are affected, only a few species are involved, and so far there is no evidence of a permanent change in the range of a species through the action of tropical cyclones. The birds so exiled either return to their original areas or die in their new unfamiliar environment. Even an inveterate wanderer like the Tropic Bird does not readily spread to new localities which it may occasionally visit. *Fortuitous bird transportation* may be a factor in the colonization of new areas by animal species, but only if these new areas provide a favourable environment. Obviously enough, the south-western part of Western Australia cannot be favourable environment for the tropical species which are affected by tropical cyclones — even if some individuals survive the drought of the first summer after their transportation, the cold of the following winter is certain to prove lethal.

(To be continued)

COMMON TERN *Sterna hirundo hirundo* IN WESTERN AUSTRALIA

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On January 7, 1956, Mr. Kevin Reed of Bassendean picked up an exhausted tern on Coogee Beach, four miles south of Fremantle. It was banded with a Swedish band, number YK 2201, and was taken home where it died next day. The band was given to the writer who took steps to recover the body which had been buried. The body is now preserved in alcohol and is at present in the collection of the Wildlife Survey Section of C.S.I.R.O.

Advice from Sweden indicated that the band was placed on a nestling Common Tern (*Sterna hirundo hirundo*) on July 9, 1955, at Marum 21 km. ENE Norrtälje in the Swedish province of Uppland. This specimen had therefore travelled 13,000 miles (around the Cape) in six months.

This tern is a holarctic breeding species which migrates south in the northern winter. The species is split into several sub-species